# Delfi-C$^3$

# A Student Nanosatellite Test-bed for in-orbit Demonstration of Micro Systems Technology

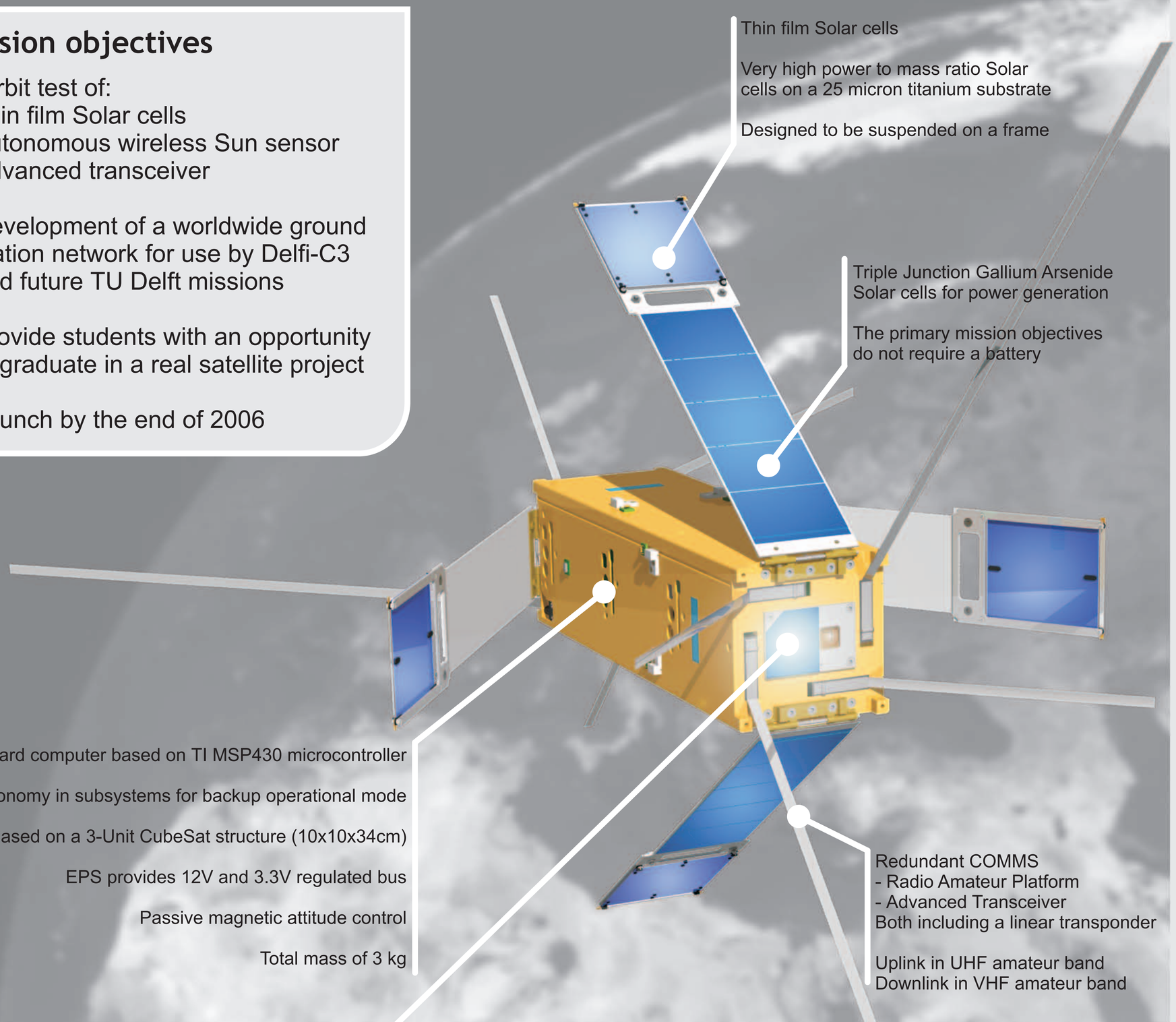
## Mission objectives

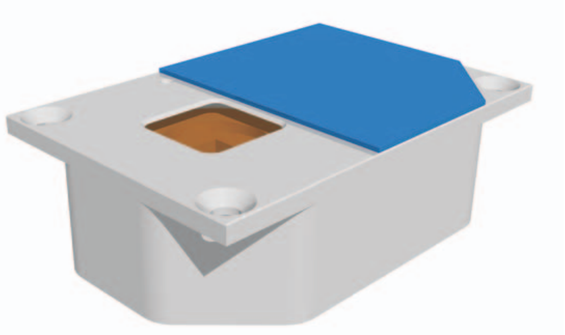
In-orbit test of:
- Thin film Solar cells
- Autonomous wireless Sun sensor
- Advanced transceiver

- Development of a worldwide ground station network for use by Delfi-C3 and future TU Delft missions

- Provide students with an opportunity to graduate in a real satellite project

- Launch by the end of 2006

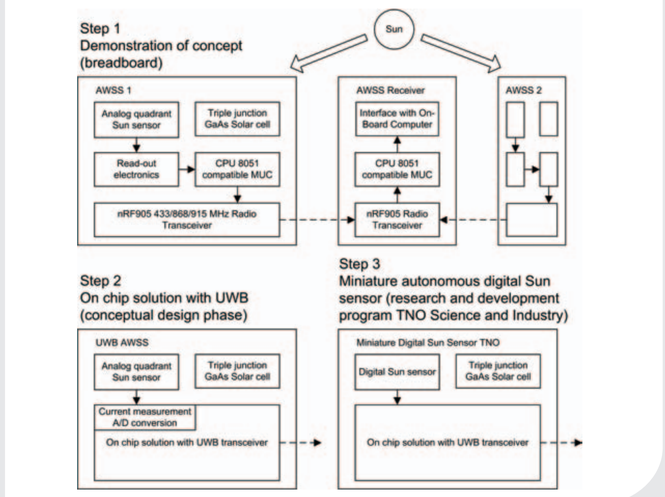


## The autonomous wireless Sun sensor

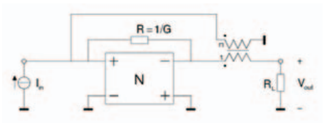
is being developed together with TNO as a proof of concept for a miniature digital Sun sensor. The Sun sensor has an independent power supply from a triple junction Solar cell and a radio link with the Delfi-C3 command and data handling system.

## Sun sensor hardware block diagrams
## A step by step development approach




## Advanced transceiver

- Integrated on-chip
- Variable output power
- Load side power management
- Focus on high efficiency miniaturized linear PA
- Prequalification for application in MISAT program
- Provides telemetry and telecommand
- Double loop negative feedback technique



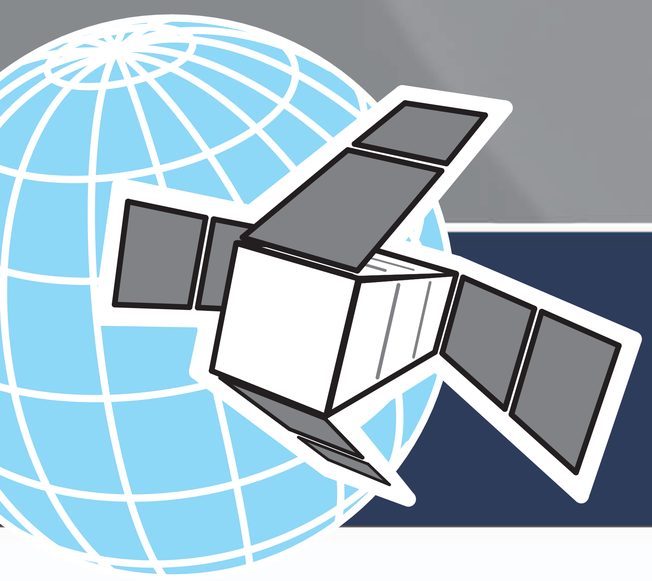

**Micro- and nanotechnologies** are playing an ever increasing role in the development of space systems as these systems typically have stringent size, mass and power consumption constraints. New design solutions for space vehicles or payloads become possible through the use of micro- and nanotechnology. Often, the performance can increase due to the high level of integration of different functions in a single component.

**Nanosatellites can be a qualification platform** for micro- and nanotechnologies. Traditionally, space qualification of technology involves extensive test programs at expensive test facilities. Only after such qualification can the technology be applied in a space mission for a first in-orbit demonstration, which improves confidence in the technology even more. However, since nanosatellite missions can be much cheaper than traditional large satellite missions, they can also take more risk in applying new technologies and proceed to in-orbit demonstration on a much smaller budget. Micro- and nanotechnology are characterized by their small size, low mass and low power demand, and this makes them ideal for qualification using a nanosatellite.

**The CubeSat standard** is the emerging standard for such satellites. It was initiated by Stanford University's Space Systems Development Lab and California Polytechnic State University San Luis Obispo. The standard is aimed at university projects and other non-commercial applications. This effort led to a first launch of several university CubeSats in June 2003. Since then the concept has been adopted by industry. Commercial CubeSat kits and several subsystems are available that can be used as a basis for a complete satellite. Launch services are brokered by Cal Poly and the University of Toronto Institute for Aerospace Studies for as little as $40,000 for a satellite of 1 kg and a volume of 10x10x10 cm.

**Delfi-C3, a two-year student satellite project** of the Faculty of Aerospace Engineering and the Faculty of Electrical Engineering, Mathematics and Computer Sciences of Delft University of Technology in the Netherlands is based on this CubeSat standard. The Delfi-C3 satellite will act as a technology testbed for three payloads. A thin film Solar cell experiment will be performed to verify the performance of these cells in the space environment. In addition, an autonomous Sun sensor using a wireless data link will be demonstrated. The third new technology will be an advanced high efficiency transceiver sized for application in pico- and nanosatellites. Delfi-C3 is scheduled for a piggyback launch in the end of 2006 and is a precursor to the extensive MISAT program, starting in 2005, which aims to develop micro- and nanosatellites that demonstrate a wide range of Micro Systems Technology and Micro-Electronics for use in spacecraft. A number of successors for Delfi-C3, based on the CubeSat concept, are foreseen to provide early in-orbit demonstration of these technologies every one or two years.

*Group photo after the Preliminary Design Review on 28th June 2005. Currently, 16 students, more than 10 TU Delft employees, a number of people in Dutch Space and TNO and even more external advisors are involved in the mission.*



G.T. Aalbers, A.R. Bonnema, E.D. van Breukelen, J.H. Doorn, R. van den Eikhoff, R.J. Hamann, E. van der Linden, J. Rotteveel, W.J. Ubbels, C.J.M. Verhoeven

phone: +31 (0)15 278 7586 e-mail: info@delfic3.nl further information: www.delfic3.nl

Project partners: Dutch Space TNO

TU Delft
Delft University of Technology